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A peculiar Case of contact Irritability

BY F. GRACE SMITH

In connection with some experiments upon factors determining the radiation of shoots, several pots of bush-beans were grown in the dark. When the seedlings, perfectly etiolated, were about 20 inches high and had developed their first leaves, a peculiar adjustment was noticed in them. The petioles had arranged themselves in parallel planes. Another set of beans was planted in 6-inch pots, one pot kept in a black box, the control experiment in a propagating room of the greenhouse, which was lighted mostly from overhead but partly from the north. Each pot contained ten beans in sphagnum moss, planted in a circle, 2 cm. apart with the hypoctyl of each turned toward the center of the pot. The box, in which the experiment was carried on, was absolutely dark, except when the plants were watered and observed, a few minutes each day. In three weeks this parallel adjustment was seen in the pot kept in the dark (Fig. 1). There was but one exception in the eight seeds which germinated. No such adjustment could be seen in seedlings grown in light, or in succeeding experiments in the light.

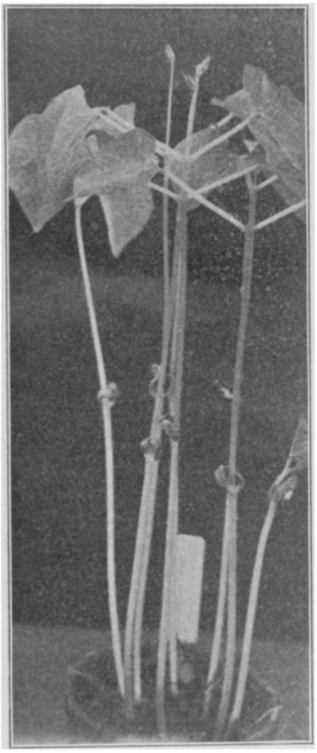


FIG. 1.

To determine if this position was constant, other pots were planted in the same way, using eight seeds to a pot in most cases. Not every pot showed so large a proportion of petioles, in parallel planes but in almost every case more than three, usually four or five, were in the same plane, whereas normally but two should be. In one pot all seven which germinated were in the same plane; in other cases five or six out of seven. Some in each pot had the epicotyl twisted, showing the adjustment was not the result of the position in which the seeds were planted. To investigate this more conclusively, sets of beans were planted in different ways.

(1) In a circle but with hypocotyl of each of the eight beans pointing in the same direction (Fig. 2). Of the six which had germinated on January 27th and unfolded their first leaves all were in the same plane (Fig. 3). January 30th, eight were large enough to be diagrammed; four were in the same plane, four others were in a plane at about an angle of 15° from this (Fig. 4).

(2) Twelve beans were planted in a cross, but with the hypocotyl of each turned in the same direction (Fig. 5). The resultant position is shown in Fig. 6. A 12-inch pot was used in this case.

(3) Nine beans were planted in a straight line, but with the hypocotyls turned in the same direction and toward each other (Fig. 7). The result is shown in Fig. 8. If a very large pot was used where no two seedlings could touch, there was no such adjustment (Fig. 9).

Other pots were planted with hypocotyl directed up or down, out or in, also with seeds on flatter surface and hypocotyls turned in different ways. There was no difference in the resultant positions. The position of planting, therefore, does not determine the adjustment, for good cases of parallelism in the petioles were found, whatever the original positions of the seeds. Therefore, the resultant plane is not brought about by internal causes, but is a response to external stimuli.

To test varying thermotropism and hydrotropism in the box, pots of beans were placed in different parts of the box. They continued to set their leaves in planes, bearing no constant relation to the sides of the box. Two pots also were placed in another case made of glass and darkened; one pot put on a clinostat revolving once in fifteen minutes, the other kept stationary. Of the eight beans which germinated on the clinostat six were in the same plane, although the leaves of one were not quite unfolded; one was not free from the cotyledons and one was at right angles.

The influence of the two stimuli, thermotropism and hydrotropism, must therefore be excepted.

Two pots were put into the same box with an electric fan keeping the air constantly in motion. The pot on the clinostat showed parallel adjustment very well (Fig. 10), also the stationary one (Fig. 11). The stillness of the air, therefore, makes no difference.

Chemotropism and hydrotropism, exerted by the leaves of neighboring seedlings, might furnish a stimulus but were not experimented with, because the stimulus to be described seemed sufficient to account for the phenomenon.

Of the mechanical forces, acting as irritable stimuli, pressure, strain and injury were not present, but certain observations made contact seem a possible factor and experiments were devised to test this.

Sets of beans were carefully matched and their positions plotted every other day. The plane of petioles and leaves was constantly changing but the final position was in a number of cases the position of the bean which first started from the cotyledon or at least the resultant position was the same for leaves which had been in contact. There was no chance for any contact in beans planted in 12-inch pots and the final positions showed no parallel adjustment.

Beans which were fully grown were placed so that the tip of the leaf of one seedling touched the leaf of another seedling. The diagrams 12, 13, 14 and 15 show the change of position.

The tendency as here shown is to take a parallel position. The movement is best seen when seedlings are not quite full grown. If contact can then change the position of the leaves, it must be possible to change the position at will. Paper leaves were fastened to standards and allowed to just barely touch the leaves of a seedling (Fig. 16, *a*). An angle of 25° was reached in all cases (Fig. 16, *b*). (Beans, kept in absolute darkness and watered by an outside tube did not unfold the plumule, but showed a movement of a quarter of an inch from the paper leaves.) Circumnutation alone, of course, could not bring about this definite fixed position.

Contact seems to work when light is present but is generally marked by the more noticeable light adjustment. One pot of beans, planted in a circle, was kept revolving upon a clinostat in light. Fig. 17 shows the final position. The parallel adjustment was not so plain at first, but became more definitely marked with the growth of the seedlings.

One seedling of this set was kept, when the others were destroyed and was irritated by two leaves of thin mica, fastened to a stick placed in the pot. The whole thing was then revolved upon a clinostat. By this means the direct influence of heliotropism was neutralized and all shading from leaves was prevented. With each of three trials the seedling cotyledons moved one half inch from the artificial leaves.

Under ordinary circumstances of growth the plants experimented upon try to expose as much surface to the light as possible for photosynthesis. Heliotropism is the stimulus for this exposure, but, when light is withdrawn or, perhaps, during the night when growth is active, the plants must make use of some other stimulus to determine other positions. Contact is always present and is apparently the stimulus used by the plants. It is probable that this influence is a secondary one, acting in light as well as in darkness. The cases where currents of air were allowed to act upon the plants showed good adjustment, for by means of them the number of contacts of the leaves was increased.

Description of Figures

FIG. 1. Photograph showing parallel adjustment of petioles in bean seedlings grown in the dark.

FIGS. 2, 3, 4. Diagrams of positions of seeds as planted in Exp. I. and the resultant positions of petioles.

FIGS. 5, 6. Diagrams illustrating planting of seeds in Exp. II. and resultant positions of petioles.

FIGS. 7, 8. Diagrams illustrating 1st part of Exp. III.

FIG. 9. Diagram illustrating 2d part of Exp. III.

FIG. 10. Diagram of resultant positions of petioles in seedlings, grown in dark upon clinostat, acted upon by currents of air.

FIG. 11. Diagram of seedlings, grown in the dark and kept stationary, acted upon by currents of air.

FIGS. 12, 13, 14, 15. Diagrams of 4 examples of seedlings, whose leaves were placed in contact and the resultant changes in their positions.

FIG. 16. Diagram of seedlings, whose leaves were irritated by paper leaves and the consequent changes in their positions.

FIG. 17. Diagram of resultant position of petioles in seedlings, grown in light upon clinostat.

Fig. 2.

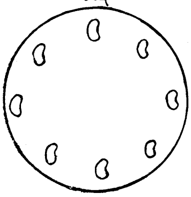


Fig. 3.

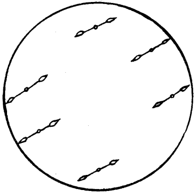


Fig. 4.

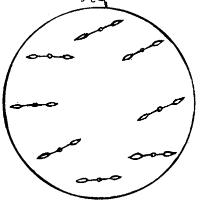


Fig. 10.

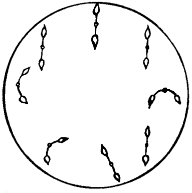


Fig. 5.

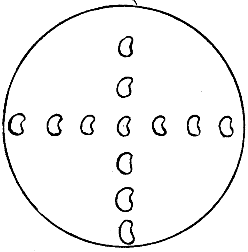


Fig. 6.

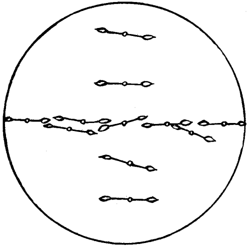


Fig. 9.

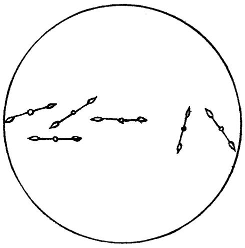


Fig. 7.

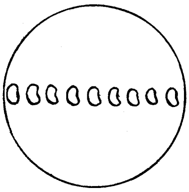


Fig. 8

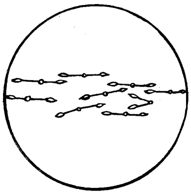


Fig. 11

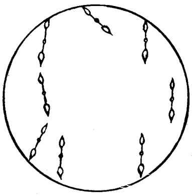


Fig. 17.

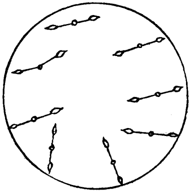
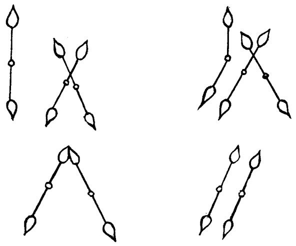
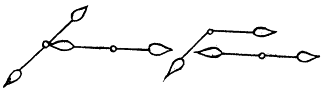


Fig. 12.



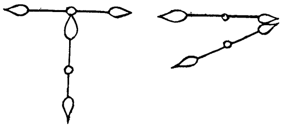
a. b.

Fig 13.



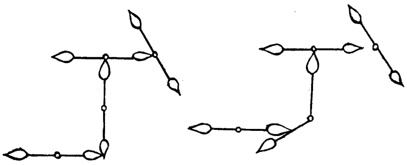
a. b.

Fig. 14.



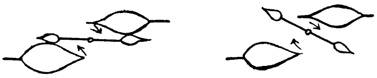
a. b.

Fig. 15.



a. b.

Fig. 16.



a. b..